T07D03 – 7.2b IB Practice

Name……………………………………………………..

1. The table below gives information about the percentage yield of ammonia obtained in the Haber process under different conditions.

Pressure/ atmosphere	Temperature/°C			
	200	**300**	**400**	**500**
10	50.7	14.7	3.9	1.2
100	81.7	52.5	25.2	10.6
200	89.1	66.7	38.8	18.3
300	89.9	71.1	47.1	24.4
400	94.6	79.7	55.4	31.9
600	95.4	84.2	65.2	42.3

(a) From the table, identify which combination of temperature and pressure gives the highest yield of ammonia.

……………………………………………………………………………………

(1)

(b) The equation for the main reaction in the Haber process is

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ ΔH is negative

Use this information to state and explain the effect on the yield of ammonia of increasing

(i) pressure: ……………………………………………………………………

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……………………………………………………………………………………

(2)

(ii) temperature: ……………………………………………………………

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……………………………………………………………………………………

(2)

(c) In practice, typical conditions used in the Haber process are a temperature of 500 °C and a pressure of 200 atmospheres. Explain why these conditions are used rather than those that give the highest yield.

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……………………………………………………………………………………

(2)

(d) Write the equilibrium constant expression, K_c, for the production of ammonia.

……………………………………………………………………………………

……………………………………………………………………………………

(1)

(Total 8 marks)

2. Consider the following reaction in the Contact process for the production of sulfuric acid for parts (a) to (d) in this question.

$$2SO_2 + O_2 \rightleftharpoons 2SO_3$$

(a) Write the equilibrium constant expression for the reaction.

(1)

(b) (i) State the catalyst used in this reaction of the Contact process.

(1)

(ii) State and explain the effect of the catalyst on the value of the equilibrium constant and on the rate of the reaction.

(4)

(c) Use the collision theory to explain why increasing the temperature increases the rate of the reaction between sulfur dioxide and oxygen.

(2)

(d) Using Le Chatelier’s principle state and explain the effect on the position of equilibrium of

(i) increasing the pressure at constant temperature.

(2)

(ii) removing of sulfur trioxide.

(2)

(iii) using a catalyst.

(2)

(Total 14 marks)

3. Many reversible reactions in industry use a catalyst. State and explain the effect of a catalyst on the position of equilibrium and on the value of K_c.

(Total 4 marks)

4. Which statement(s) is/are true for a mixture of ice and water at equilibrium?

I. The rates of melting and freezing are equal.

II. The amounts of ice and water are equal.

III. The same position of equilibrium can be reached by cooling water and heating ice.

A. I only

B. I and III only

C. II only

D. III only

5. The manufacture of sulfur trioxide can be represented by the equation below.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \Delta H^{\ominus} = -197 \text{ kJ mol}^{-1}$$

What happens when a catalyst is added to an equilibrium mixture from this reaction?

A. The rate of the forward reaction increases and that of the reverse reaction decreases.

B. The rates of both forward and reverse reactions increase.

C. The value of $\Delta H^{\ominus}$ increases.

D. The yield of sulfur trioxide increases.

6. What is the equilibrium constant expression, K_c, for the reaction below?

$$N_2(g) + 2O_2(g) \rightleftharpoons 2NO_2(g)$$

A. $K_c = \dfrac{[NO_2]}{[N_2][O_2]}$

B. $K_c = \dfrac{2[NO_2]}{3[N_2][O_2]}$

C. $K_c = \dfrac{[NO_2]^2}{[N_2][O_2]^2}$

D. $K_c = \dfrac{[NO_2]^2}{[N_2]+[O_2]^2}$

7. Iron(III) ions react with thiocyanate ions as follows.

$$Fe^{3+}(aq) + CNS^{-}(aq) \rightleftharpoons Fe(CNS)^{2+}(aq)$$

What are the units of the equilibrium constant, K_c, for the reaction?

A. mol dm^{-3}

B. mol^2 dm^{-6}

C. mol^{-1} dm^3

D. mol^{-2} dm^6